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EFFECT OF TRANSPLANTING DATES ON PADDY YIELD OF FINE GRAIN RICE GENOTYPES

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Abstract

Field studies were carried out to investigate the effect of various transplanting dates on the yield and yield related parameters as well as flowering behaviour of fine rice grain rice genotypes. The experiment was conducted for three successive years from 2004 to 2006. Rice genotypes viz., 98410, 98316,99417, 99512, 99513, 98408, 00521-1, 98404, Basmati 385and Super Basmati were kept in 6 transplanting dates viz., 16th May, 1st June , 16th June, 1st July, 16th July and 1st August during each year. The 3 years average data showed that maximum number of fertile tiller hill^{-1} (19.1) was recorded in 1st June transplanting date, whereas, plant height (172.1 cm), grains panicle^{-1} (119.3), 1000 grain weight (21.58) and paddy yield (3.95 t ha^{-1}) were highest in 16th July transplanting dates, irrespective of genotypes. However, minimum paddy yield was recorded in 1st August transplanting date. Regarding rice genotypes, 99417 produced highest plant height (173.5 cm) and 1000 grain weight (23.88 g) but lowest paddy yield (2.82 t ha^{-1}), whereas, 98408 and 99513 gave maximum values of productive tillers hill^{-1} (24.64) and grains panicle^{-1} (138.5), respectively. Fine grain rice genotype 99512 showed best yield performance by producing 4.17 t ha^{-1} paddy yield. Therefore, 16th July was found to be the best date of transplanting and genotype 99512 showed best performance among all the genotypes studied. Flowering behavior showed that all genotypes were photoperiod sensitive except 98410 which showed that it was a non-basmati fine grain genotype.

Introduction

Rice (*Oryza sativa* L.) is an important cash crop of Pakistan. Basmati is premium rice which fetched more than 1.2 billion dollars valuable foreign exchange for Pakistan by exporting about 3.6 million tons during the last year (Anon., 2006-07). The average yield of rice in Pakistan has been increased as a result of many activities by more than 2% per year but still far less than other leading rice growing countries (Ito *et al*., 1989). Sowing and transplanting at the optimum time is important for obtaining high paddy yield. Too early or too late transplanting causes yield reduction due to crop sterility and lower number of productive tillers, respectively (Nazir, 1994). Vandana *et al*., (1994) reported that dry matter accumulation in leaves decreased in test cultivars (PR-106, PR-109 and Basmati-370) with later transplanting dates. They further observed that delayed transplanting reduced seedling dry matter in PR-106 and PR-109, but an increase was observed in Basmati-370 with least accumulation of dry matter in leaves. Munda *et al*., (1994) obtained higher grain yield of rice (cvs. Khonorulla and PK-1-3 by transplanting on 15th June as compared with 1st July. Bali & Uppal (1995) concluded that rice crop transplanted on 10th July gave 9.4 to 17.9% higher grain yield than 30th July transplanting due to higher root density, NPK uptake and head rice recovery. Gangwar & Sharma (1997) obtained maximum grain yield by transplanting on 1st to 16th July as compared with 31st July and 16th August. Maximum panicles were observed in early planting (1st July) but panicle weight was non-significantly affected up to 16th July. While studying the effect of transplanting time on yield of basmati rice strains Ahmad *et al*., (2006) found that maximum paddy yield was achieved by rice genotypes 98316 and Super

Basmati when transplanted on 16th July. However, average paddy yield across all basmati strains was found to be highest in 1st July transplanting date. Akram *et al*., (2007) reported that yield and yield parameters like number of tillers, grains per panicle, plant height, 100 grain weight and sterility of different rice varieties/lines were significantly affected by transplanting dates. Rashid *et al*., (2007) noted that through induced mutation, yield and yield components of basmati rice varieties can be genetically improved.

The fine grain basmati varieties of rice are considered high quality rice and fetch a high price in national and international trade. However, yield per unit area of basmati rice is very low due to tall plant habit and late maturity (Rashid *et al*., 2003) Flowering behaviour is also an important character which distinguishes basmati rice from non basmati rice. All traditional basmati varieties are highly photoperiod sensitive with respect to flowering. These are tall statured, having weak culm, low yield and prone to lodging. At the time of selection of a basmati variety, special attention is given to those varieties which show photosensitivity. Super Basmati is a typical form of basmati rice and photoperiod sensitivity is its major character (Rafiq *et al*., 2005).

Rafiq *et al*., (2005) tested the flowering behaviour of different fine grain rice genotypes in order to screen true basmati or photoperiod sensitive rice varieties and found that rice genotype 98408, 98316, 99417, 99512 and 99513 showed photoperiod sensitivity in the same pattern as was expressed by Super Basmati and hence could be categorized as basmati strains. Qamar *et al*., (2005) concluded that in the aromatic rice, days-to-50% flowering and days-to-maturity exhibited highly significant negative genetic association with grain yield per plant. Moreover, productive tillers per hill, spikelets per panicle, fertility %age and plant height may be considered as the selection criteria for the direct improvement of grain yield in the aromatic group.

The present study was conducted to find out the optimum transplanting time for the fine grain rice genotypes and to screen out true basmati fine grain genotypes by studying their flowering behaviour.

Materials and Methods

A 3 year study was conducted at Rice Research Institute, Kala Shah Kaku, Lahore, during 2004 to 2006. During each year, 10 fine grain rice lines/varieties were subjected to six transplanting dates viz., 16th May, 1st June, 16th June, 1st July, 16th July, and 1st August. Trial was replicated thrice in a split plot design. The net plot size was 2.25 x 6.75 m^2. Transplanting dates were kept in the main plot while stains/ varieties in sub-plot. Row to row and plant to plant distance was 22.5 cm. For each transplanting date in each variety, 30 days old nursery was used. N-P-K fertilizer was used @ 133-85-62 kg/ha. Whole Phosphorus and Potash and 1/3 nitrogen were applied at land preparation while 2/3 N was applied at 25 and 45 days after transplanting (DAT) in two equal splits. Machete 60EC was applied (2 t/ha) to control weeds just after four days of transplanting. The remaining (fallow) weeds were controlled manually. $ZnSO_4$ (35%) was applied @ 12.5 kg/ha at 12 DAT. Data of flowering was recorded by visiting the field daily and days to 100% flowering were computed by computing the days from transplanting to 100% flowering when all the plants in a plot flowered. Super Basmati, a photoperiod sensitive basmati variety, was kept as standard and its flowering behaviour was taken as a criterion to identify a rice strain to be photosensitive and basmati rice genotype. Yield and yield related parameters were recorded at maturity. Data of 3 years showed a similar trend, therefore these were pooled and 3 year average data calculated were analyzed statistically by using Fishers analysis of variance technique and treatment means were compared with each other by Duncan's Multiple Range (DMR) test (Steel & Torrie, 1984). The differences were only considered when significant at $p \leq 0.05$.

Results and Discussion

It can be observed from Fig. 1 that plant height of different genotypes of fine rice was affected significantly when assessed through the interaction of varieties and transplanting dates. Fine grain rice genotype 99521 showed maximum plant height (195 cm) in 16th June transplanting date, which was significantly different from all other treatment combinations. However, minimum plant height was recorded in Super Basmati when transplanted on 16th May. Means of varieties across 6 transplanting dates as presented in Table 1 showed that genotype 99417 produced maximum plant height (173.5 cm), which was significantly different from all other genotypes. However minimum plant height (125.5 cm) was recorded in rice genotype 98404. Maximum plant height of 173.5 cm was noted for genotype 99417. In the same way, average plant height across 10 rice strains indicated that rice transplanted on 16th June produced maximum plant height of 172.1 cm, which remained statistically at par with that recorded in transplanting dates from 16th May to 1st June. However, minimum height of 108.8 cm was noted for genotypes transplanted on 1st August irrespective of varieties (Table 2). These results are in accordance with the findings of Vandana *et al*., (1994) and Akram *et al*., (2007). Increased plant height in earlier transplanting dates was due to availability of prolonged period for vegetative growth to rice genotypes in these dates.

The ability of various fine rice genotypes to produce panicle-bearing tillers was affected significantly with different transplanting dates. Maximum tillers (19.10) were produced by all genotypes transplanted on 1st June which was statistically at par with that in 16th May and 16th June transplanting dates, whereas, the minimum value of 17.35 tiller hill^{-1} was recorded in transplanting date of 1st August irrespective of various genotypes (Table 2). When data were averaged across dates for the comparison of various genotypes, it was noted that genotype 98408 produced maximum tillers (24.64), which was followed by genotype Super Basmati producing 23.61 tillers hill^{-1}. However, minimum tillers (10.17) were produced by genotype 99417 (Table 1). The interaction between various genotypes and transplanting dates is shown in Fig. 2 which indicated that Super basmati gave maximum number of fertile tillers hill^{-1} (26.53) when transplanted on 1st June against minimum number of fertile tiller (9.57) shown by genotype 99417 in 16th June transplanting date. These results are in consonance with the findings of Gangwar & Sharma (1997) who also observed more number of panicles in early transplanting than in late transplanting. This was due to the fact that rice genotypes planted earlier had longer period for their vegetative growth compared to those sown later.

The interaction between different fine rice genotypes and transplanting dates for producing the number of grains per panicle was significant when seen statistically (Fig. 3). Rice strain 99513 gave maximum number of grains panicle^{-1} (154.3) in 16th June transplanting date, whereas, minimum number of grains panicle^{-1} (76.29) was recorded in Super basmati variety when transplanted on 16th May. Genotype means across 6 transplanting dates showed that maximum number of grains per panicle (138.5) was recorded from genotype 99513 which was statistically similar with genotype 99512 producing 131.7 grains per panicle (Table 1). On the other hand, maximum grains from single panicle (119.3) irrespective of variety were counted from fine rice genotypes transplanted on 16th July which remained statistically at par with that transplanted on 1st July. However, minimum number of grains (99.87) was noted in genotypes transplanted on 16th May (Table 2). Gangwar & Sharma (1997) found similar results. Nazir (1994) reported that earlier transplanting in rice causes lower number of grains panicle^{-1} due to grain sterility because of high temperature at the time of grain maturation. Transplanting at its optimum time reduces grain sterility.

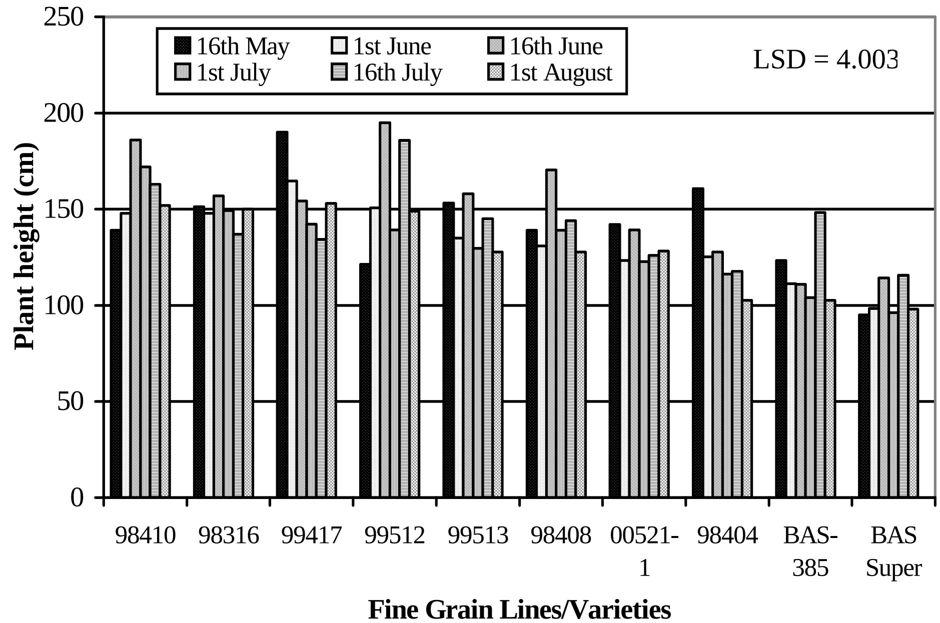

Fig. 1. Plant Height (cm) of 10 fine grain rice genotypes as affected by six transplanting dates.

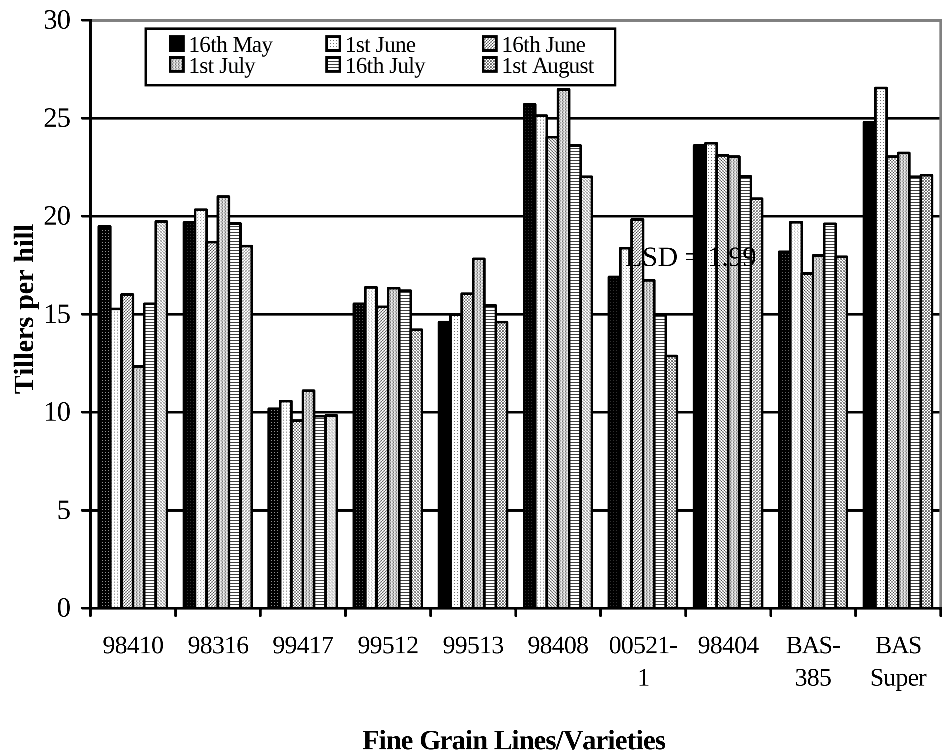

Fig. 2. Tillers Hill^{-1} of 10 fine grain rice genotypes as affected by six transplanting dates.

Table 1. Means of fine grain rice genotypes across 6 transplanting dates of yield, yield components and flowering.

Genotypes	Parameters					
	Plant height (cm)	**Tillers per hill**	**Grains per panicle**	**1000-grain weight (g)**	**Paddy yield (t/ha)**	**Days to 100% flowering**
98410	141.2 bc	16.39 fg	102.3 c	21.38 cd	3.54 bc	73.56 g
98316	133.4 e	19.63 d	115.3 b	19.54 f	4.10 ab	95.45 c
99417	173.5 a	10.17 h	104.3 c	23.88 a	2.82 d	91.97 e
99512	142.1 b	15.67 g	131.7 a	22.21 b	4.17 a	93.78 d
99513	139.6 c	15.58 g	138.5 a	22.04 bc	3.95 abc	92.81 d
98408	128.6 f	24.64 a	97.61 cd	20.56 e	3.78 abc	99.02 b
00521-1	136.3 d	16.61 f	113.9 b	21.62 bcd	3.73 abc	88.08 e
98404	125.5 g	22.73 c	92.79 de	20.49 e	3.44 c	92.89 a
BAS 385	133.6 e	18.41 e	117.6 b	18.78 g	3.46 c	88.73 f
Super Bas	126.6 g	23.61 b	88.88 e	21.01 de	3.35 cd	100.94 a
LSD (5%)	**1.634**	**0.81**	**6.97**	**0.6781**	**0.5435**	**1.161**

Means followed by different letters in a column are significantly different at $p<0.05$

Table 2. Means of transplanting dates across 10 fine grain rice genotypes of yield, yield components and flowering.

Transplanting Date	Parameters					
	Plant height (cm)	**Tillers per hill**	**Grains per panicle**	**1000 Grain weight (g)**	**Paddy yield (t/ha)**	**Days to 100% flowering**
16^{th} May	157.0 ab	18.86 ab	99.87 d	20.79 b	3.54 b	115.36 a
1^{st} June	170.4 a	19.10 a	100.6 d	21.07 ab	3.64 b	106.87 b
16^{th} June	172.1 a	18.61 abc	114.6 b	21.43 a	3.61 b	95.19 c
1^{st} July	138.4 abc	18.27 bc	117.6 ab	21.40 a	3.83 a	87.25 d
16^{th} July	124.3 bc	17.88 cd	119.3 a	21.58 a	3.95 a	77.37 e
1^{st} August	108.8 c	17.35 d	109.9 c	20.63 b	3.03 c	68.29 f
LSD (5%)	**42.31**	**0.7011**	**4.426**	**0.5169**	**0.2148**	**0.8630**

Means followed by different letters in a column are significantly different at $p<0.05$

Data indicated that difference among various genotypes for 1000 grains weight was significant statistically irrespective of transplanting dates (Table 1). Genotype 99417 produced 1000 grains with maximum weight (23.88 g) in contrast to genotype Bas 385 which produced minimum 1000 grains weight valued at 18.78 g. Similarly, means of transplanting dates across genotypes expressed that maximum weight for 1000 grains (21.58 g) was noted for genotypes transplanted on 16th July while genotypes transplanted on 1^{st} June, 16^{th} June and 1^{st} July also showed non-significant difference with it regarding this parameter (Table 2). Interaction between various genotypes and transplanting dates, as depicted in Fig. 4, also remained significant when examined through statistics. Rice strain 99417 produced maximum weight of 1000 grains (24.5 g) in 16^{th} June transplanting date in contrast with Basmati 385 which gave minimum 1000 grain weight valued at 17.4 g in 16^{th} May transplanting. These results are in line with the observations of Gangwar & Sharma (1997) who found that panicle weight was non-significantly affected up to 16^{th} July. It was due to the fact that fine grain rice transplanted between June and July attains maximum grain weight due to availability of suitable temperature during grain growth.

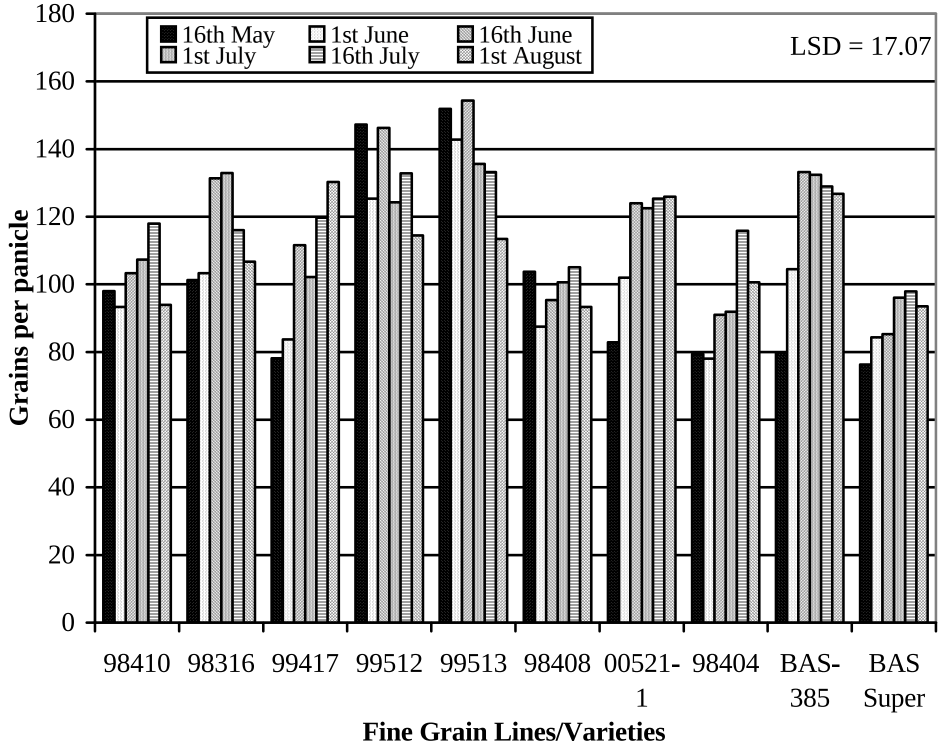

Fig. 3. Grains Panicle^{-1} of 10 fine grain rice genotypes as affected by six transplanting dates.

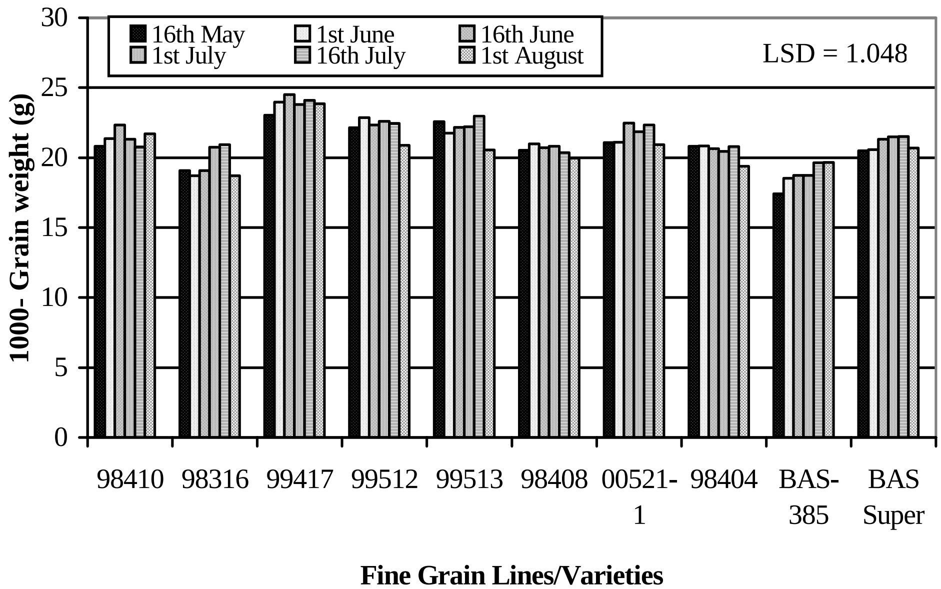

Fig. 4. 1000 grain weight (g) of 10 fine grain rice genotypes as affected by six transplanting dates.

The most important parameter and ultimate task of farming is paddy yield which was affected significantly with various genotypes as well as transplanting dates. It can be observed from data of Table 1 that genotype 99512 produced maximum paddy yield of 4.17 t ha^{-1} and it remained statistically at par with 98316, 99513, 98408 and 00521-1 genotypes with 4.10, 3.95, 3.78 and 3.73 t ha^{-1} paddy yields. The genotype 99417 gave minimum paddy yield (2.82 t ha^{-1}). Paddy yield averaged across all the genotypes seems to be maximum (3.95 t ha^{-1}) in transplanting date of 16^{th} July which is statistically similar with that obtained in 1^{st} July transplanting date. However, the lowest yield of paddy (3.03 t ha^{-1}) was recorded in transplanting date of 1^{st} August. Interaction between transplanting dates and genotypes showed that rice genotype 99512 gave highest paddy yield of 4.92 t ha^{-1} in 1^{st} June transplanting date (Fig. 5), whereas, lowest paddy yield (1.59 t ha-^{1}) was recorded in genotype 99417 when transplanted on 1^{st} June. Similar results were reported by Akram *et al*., (2007) who found higher paddy yield in earlier transplanting dates compared with the late transplanting. Ahmad *et al*., (2006) claimed that among various basmati strains tested, 98316 and Super Basmati gave higher paddy yield in transplanting date of 16^{th} July. The findings of Munda *et al*., (1994), Bali & Uppal (1995) and Gangwar & Sharma (1997) were also in the same direction. Higher paddy yields in 1^{st} July and 16^{th} July transplanting dates were the resultant of greater number of fertile tiller $hill^{-1}$, grains $panicle^{-1}$, 1000 grain weight obtained by these dates.

Flowering is very important parameter as flowering leads to grain formation. In addition, flowering behaviour serves as a criterion for identifying a rice genotype to be photoperiod sensitive, an important characteristics of basmati variety. Only that rice genotype was considered to be basmati that flowering behaviour was a perfect match of Super Basmati. Differences among various genotypes for days to 100% flowering were significant when assessed through the yardstick of statistics (Table 1). The longest duration to 100% flowering (100.9 days) was noted for genotype Super Bas which was followed by genotype 98404 and both these genotypes were non-significant when compared with each other. The effect of different transplanting dates on 100% flowering also remained significant (Table 2). More number of days to 100 flowering was taken by early transplanting dates in comparison with those in late transplanting dates. The interaction between different genotypes and transplanting dates remained statistically significant (Fig. 6). It can be depicted from that flowering behavoiur of all the rice strains except 98410 match to that of Super Basmati which indicates that all the rice genotypes are basmati except 98410 which is a non-basmati fine grain strain. The similar results have also been reported by Rafiq *et al*., (2005).

Conclusion

The overall results of the present investigations lead us to the conclusion that there is a significant effect of transplanting dates on the yield, yield components and days taken to 100% flowering of fine grain rice genotypes. Transplanting during 1^{st} to 15^{th} July is most suitable for obtaining better yields of fine grain rice genotypes. All the rice genotypes under studies were found to be photoperiod sensitive and hence true basmati except 98410 which was found to be a non-basmati fine grain rice genotype.

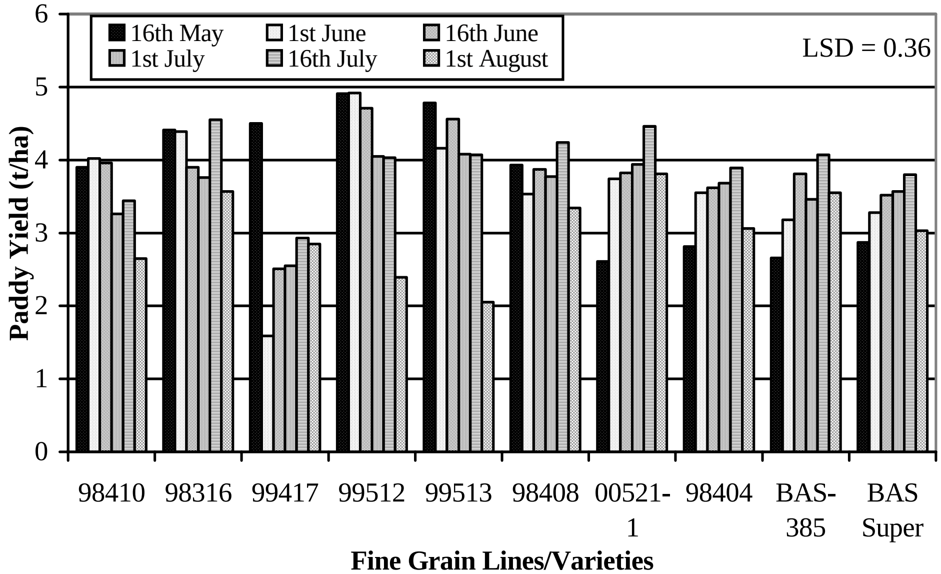

Fig. 5. Paddy Yield (t ha^{-1}) of 10 fine grain rice genotypes as affected by six transplanting dates.

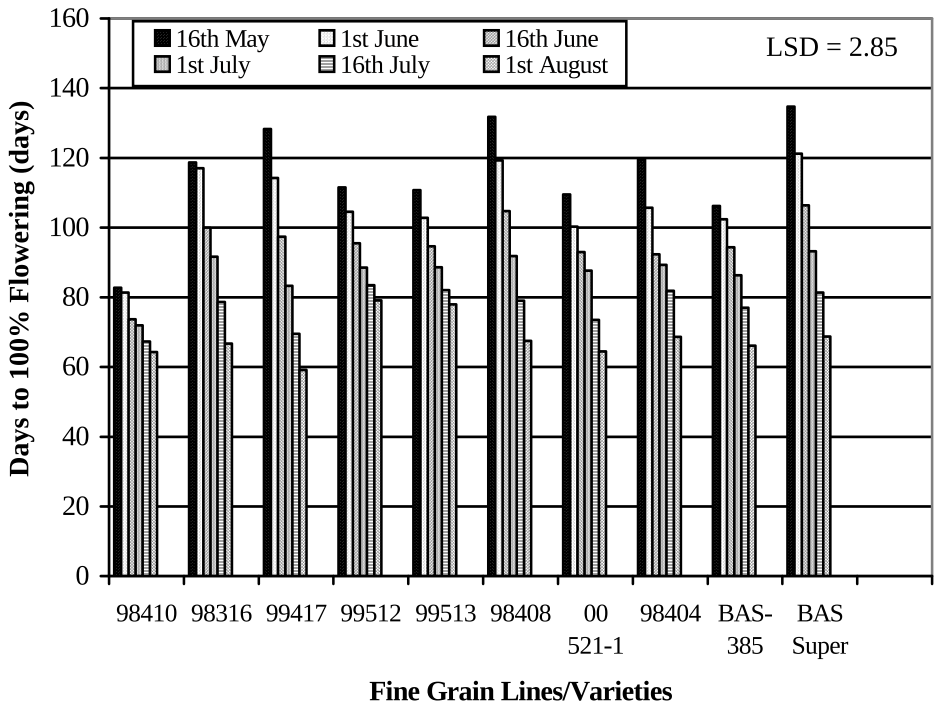

Fig. 6. Days to 100% flowering of 10 fine grain rice genotypes as affected by six transplanting dates.

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